Using UPnP* Technology to Extend the Reach of Handheld Devices

Simplifying the Network

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The opportunity

According to Gartner Dataquest* in a report released March 2002, global mobile phone sales dipped below 400 million units in 2001, the first decline in the history of the industry.[1] The cell phone industry is approaching saturation with the current generation of devices. Indeed, today's cell phone is almost a commodity; as competition eats away at profitable margins, manufacturers have a compelling reason to increase the power and functionality of their products to entice consumers to upgrade. This upgrade cycle is leading to the convergence between telephony devices (such as cell phones) and personal digital assistant (PDA) devices (such as Microsoft Pocket PC*-based devices).

"Mobile handsets are expected to be the catalyst in ensuring the convergence of mobile telecommunications, computing, and consumer electronics. Such devices are expected to represent a new class of terminals that will enable users to perform a range of computing tasks and access information and entertainment whenever and wherever they wish."[2]

However, manufacturers can't simply build a better phone, add PDA functionality, and expect consumers to reach for their wallets. They need compelling content and services for their phones — something to make consumers want to upgrade — and this can only come from applications developers. Given a powerful platform, a set of development tools, and a chance to win a slice of the lucrative communications market, developers will quickly seize the opportunity to develop enticing products.

In this paper, we examine a few usage scenarios that illustrate the opportunity for applications developers of mobile devices. Specifically, we look at how Universal Plug and Play (UPnP*) technology creates significant opportunities for new products and services. We also examine the developer tools and benefits of the Intel® Personal Internet Client Architecture (Intel® PCA) Developer Network or Intel PCADN.

Some scenarios

ARC Group market research analysts predict, "IP is set to become the medium for data transfer bringing new products such as washing machines that users are able to set remotely by phone. House owners will also be able to set alarms, heating controls, or switch on lights remotely with their handsets."[3]

In order to better understand the benefits that UPnP technology brings to the world of personal communications, let us consider the following usage scenarios.

The first scenario shows discovery and control of networked devices in the home, such as audio/video equipment or home appliances. This is possible today. In the near future, the use of proximity networking in public spaces is also a possibility.

The second scenario covers access to your home network while you are outside the home (what we call "secure home access"). This should be possible in the near future.

Finally, in the third scenario, there's the introduction of a personal Internet gateway, which allows any portable device to access the Internet through a portable wireless communications device.

Proximity networking

Proximity networking means having connectivity with all the devices within a certain context, such as your home, your small office, your car, or a public space (such as an airport or a coffee shop).

[1] Van Grinsven, Lucas, "Global Mobile Sales Dip Below 400 Million – Gartner"; Reuters; 03/10/2002.
[2] ARC Group report, "Future Mobile Handsets, 2001 Edition".
[3] Ibid.

Consider the scenario of a user who has purchased several music CDs in digital form and loaded them onto his personal computer. Often, the personal computer physically resides away from the entertainment center in a home, and as such, the playback of songs from the computer to the stereo is not convenient. What the user would really like is to be able to store all of his music, videos, and pictures on his home computer, and then be able to play back that content on whatever device he happens to be near at the time. For example, using a Pocket PC device and UPnP technology, a user can browse all of the songs stored on the home computer, select a title, and have the song played back on the stereo in the family room.

In another example, a traveling businessman makes some last-minute changes at the airport to a presentation that he has stored on his Pocket PC. Before his plane leaves, he uses his Pocket PC to locate an available printing service in the airport, uploads his updated presentation, and orders five copies to be printed. He then picks up his printout and boards the plane.

Staying connected while away from home

The number of mobile devices that are directly connected to the Internet —for example, through cellular digital packet data (CDPD) or general packet radio service (GPRS) is increasing every day. However, this type of Internet connectivity only allows a user to access data that resides on the public Internet — for example, to check his stock quotes. Stock quotes represent a category of data that is ideal for storing on the Internet because it is bandwidth friendly and has universal appeal.

In contrast to this type of data, personal data (such as personal pictures, videos, photos, and songs), or confidential information (such as tax files, account data, and passport copies) has a high value to the owner, but a low value to most of the world. The economics of such a combination make placing this category of data on the Internet unappealing (as evidenced by the recent demise of many photo- and song-sharing Web sites).

With UPnP technology, a viable option for accessing personal data emerges. First, the personal data resides on the home network, where it already exists today. The PC, with its vast storage space, high processing power, and user-friendly input devices, is the natural place for most people to store, categorize, and edit their personal data. With UPnP technology, this data is shared among the home network for other devices to access.

Second, we introduce a UPnP-enabled Internet gateway device (the “IGD”, more on this later) that connects the home network to the Internet with the necessary firewall protection. An additional module in the IGD takes responsibility for discovering UPnP devices (such as photo albums) on your home network, allowing you to access that content when you are outside the home.

For example, a woman on a business trip is waiting for a flight at the airport when she spots a friend whom she hasn’t seen in two years. After chatting for a bit, the woman wants to show her friend photos of her new house and her beloved dog. Using her Pocket PC, she securely connects into her home computer through the UPnP IGD that is inside her home. The IGD acts as relay for forwarding the UPnP technology requests from the Pocket PC to the home network to get the desired result. In this case, a list of albums is transferred back so that the woman can select one to show her friend. After picking a photo album, the woman can view the thumbnails of her pictures. She and her friend can then pick and choose which photos to zoom in on and enjoy more thoroughly.

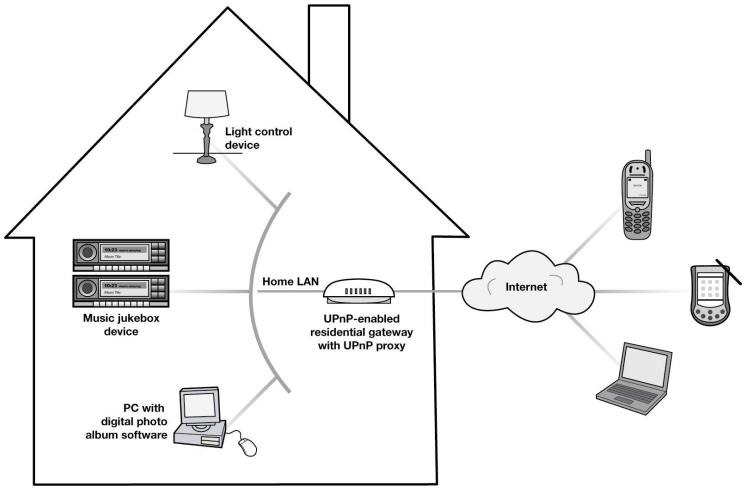

Figure 1: Access to home network from outside

Meanwhile, a man is relaxing on a Saturday at his favorite neighborhood café sipping a latte. He realizes this nearly perfect moment would be even better if he could hear his favorite music. He ripped some new songs from a CD onto his PC's hard drive the previous night and would like to listen to them now. Because the music is stored on his home computer, he can use his Pocket PC and UPnP technology to effortlessly access his new music. He simply turns on his Pocket PC, runs the secure home access application (which requires him to enter his password) and then pulls up a list of the songs, he finds the one he wants and selects it. Using quality of service and real-time media streaming techniques, the song may be automatically transcoded for optimal playback on his Pocket PC and transferred to his device in a bandwidth-friendly way. Of course, all of this activity is transparent to the man, who simply hears his song start playing.

A man is on a three-day mountain hike. As he rests by a stream, a shrill chirp from his Pocket PC interrupts the solitude of nature. He turns on the device and notices that he has received an alert from a security camera on his home network that has detected motion outside his house. He then securely accesses his home network in order to download a live video snapshot from the camera that saw the activity. He sees that a UPS* person is delivering a package. The man remotely opens the garage door for UPS to leave the package. He waits a couple of minutes and then closes the door.

Personal Internet gateway

In this section, we consider a new category of communications device, the personal Internet gateway. Like its IGD counterpart on the home network, a personal Internet gateway allows multiple devices in a personal area network (PAN) to share a single Internet connection. What is different in this scenario is that each of the devices in question is a mobile device carried by the user — for example, a cell phone, digital camera, digital audio player, or PDA.

Each of these devices has become more network-capable over the years; they are all at the point where they are network aware. However, obtaining a direct Internet connection for each of these devices is a costly proposition. Each device requires the hardware and software to exchange information directly with the Internet through a wireless WAN system, such as GPRS. Moreover, each device requires a separate account with the Internet service provider. The economics of this situation simply doesn't scale to support the usage scenario.

The personal Internet gateway addresses these issues by allowing one or more devices to use UPnP technology in combination with a wireless LAN technology (such as 802.11a/b) to discover the presence of an Internet connection. For example, consider the case of a woman who has finally gotten away from her hectic office and is setting off for a much-needed long vacation. She's not quite out of the city when she suddenly remembers she forgot to send an important e-mail. She left her laptop

computer at home, but she did bring along her Pocket PC and cell phone. She composes the e-mail on her Pocket PC and presses "send," as she would when sending any other e-mail from a desktop or laptop computer.

Normally, this e-mail would then sit in the e-mail outbox on her Pocket PC until the next time she synchronizes it with the docking cradle on her PC. Or, if her Pocket PC were equipped with direct Internet access, it would be able to send the message immediately. As discussed earlier, however, this is an expensive proposition. Using the concepts introduced in this paper, another alternative is for her Pocket PC to send a UPnP search request to all devices within wireless LAN range (for example, 802.11a/b) within range inquiring if any of them has an Internet connection (for example, GPRS). In our scenario, the woman has a cell phone with both a Bluetooth radio and a GPRS Internet connection. The Pocket PC then establishes a tunnel to the Internet through the cell phone's connection and is able to send its e-mail immediately. The cell phone has acted as a personal Internet gateway for the Pocket PC using UPnP technology.

It is important to note that, in this scenario, the 802.11 technology is being used as a personal area network (PAN) technology, not as a LAN technology. If the Pocket PC were in an 802.11 hotspot (such as near a public access point), it would be able to connect directly to the Internet through that connection. Our scenario deals with instances when a direct, high-speed Internet connection is not available. In that case, the same 802.11 technology can be used, this time as a PAN technology, to communicate with the cell phone and obtain Internet connection through its GPRS radio (as described above).

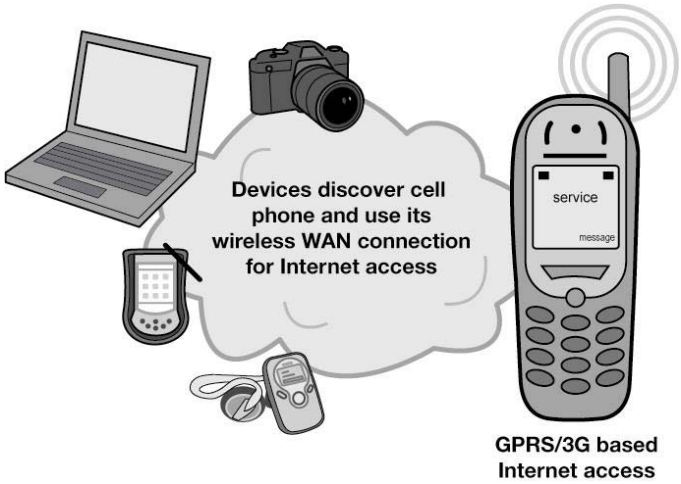

Figure 2: A UPnP-enabled personal gateway

In another example, a man is on vacation and has his digital camera and cell phone with him. He has taken some great pictures that he wants to share immediately with his friends and family. Usually, sharing photos requires that he download his pictures to his PC and then upload them to a photo-sharing Web site on the Internet. Using UPnP technology and the Personal Internet Gateway, another option is available: The camera detects the presence of a cell phone with an Internet connection and sets up a tunnel to the Internet. The camera then uploads its picture directly to the photo-sharing Web site, which has been configured to alert his friends whenever new content is added. Within minutes after uploading the photo, his friends are marveling at the adventure he is on.

Tools for creating software solutions

Software developers can give users rich media experiences like the ones described in the scenarios. UPnP architecture, IGA, Intel PCA, and Intel® UPnP software development kit (SDK) provide the building blocks to make this possible. Intel and other industry leaders have made it easy for software application developers to implement UPnP architecture into their products. Intel is a founding member of the UPnP Forum, a consortium comprised of over 450 member companies from a variety of consumer industries.

UPnP architecture

UPnP technology makes home networking invisible to the consumer. UPnP technology builds on existing Internet standards to enable PCs and intelligent networked devices in the home (such as audio and video devices and Internet gateways) to automatically connect with one another and work together without requiring the user to set up complicated network settings.

Ease of use, flexibility, and new functionality are some of the many benefits that UPnP technology provides to consumers. Networking products that include Universal Plug and Play technology will "just work" when physically connected to the home network. UPnP technology can work with essentially any networking technology in the home, be it wired or wireless. As devices and PCs are connected with one another, consumers will enjoy the innovative new services and applications that result from networking products together.

For the developer, the UPnP architecture is a framework that defines the protocols for communication between controllers, or control points, and devices. By not having to worry about designing and debugging a system to do these things, developers can focus their efforts on their products and get time-to-market advantages over their competitors.

UPnP technology is broad in scope in that it targets home networks, proximity networks, and networks in small businesses and commercial buildings. It enables data communication between any two devices under the command of any control device on the network. UPnP technology is independent of any particular operating system, programming language, or physical medium.

UPnP products support automatic networking configuration and automatic discovery, whereby a device can dynamically join a network, obtain an IP address, announce its name, convey its capabilities upon request, and learn about the presence and capabilities of other devices. Dynamic host configuration protocol (DHCP) and domain name system (DNS) servers are optional and are used if available on the network. Furthermore, a device can leave a network smoothly and automatically without leaving any unwanted state behind.

UPnP efforts benefit from the Internet's success and take advantage of its components, including IP, TCP (Transmission Control Protocol), UDP (User Datagram Protocol), HTTP (Hypertext Protocol) and XML (Extensible Markup Language). UPnP standards are driven by a multi-vendor collaboration for establishing standard Device Control Protocols (DCPs). Similar to the Internet, these are contracts based on wire protocols that are declarative, expressed in XML, and communicated through HTTP.

The UPnP architecture is architecturally neutral and works with any operating system (including Windows* and Linux*), programming language (including C++* and Java*), processor (including IA32, Intel® XScale™, and several embedded controllers), and platform. UPnP technology is a layer 4 protocol; and, as such, only requires that the TCP/IP and UDP/IP stacks are available.

The UPnP Internet gateway device

The Internet gateway is an example of a product that benefits from UPnP technology. Most gateways today employ a specific technology that allows a single Internet connection to be shared by multiple computers in the home. Unfortunately, this technology causes many compelling applications to not work correctly, including multiplayer gaming, file sharing, and real time communications (like Internet phone). In order to get these applications to work correctly, consumers must use Web browsers and other tools and be knowledgeable about networking and gateway configurations. The UPnP architecture lends itself well to the discovery, configuration, and management of an Internet gateway device (IGD).

Intel is supporting IGD functionality through its residential gateways, broadband modems, and software solutions. Recently, the company introduced the industry's first gateway product to receive the UPnP certification logo: the Intel® AnyPoint™ Networking Gateway Model 1300. Combining the functionality of a wireless access point, Internet router, and firewall, the AnyPoint Networking Gateway provides seamless discovery and configuration of UPnP-certified applications and devices. The product also extends Intel's industry leadership in UPnP implementation for Linux and UPnP Internet gateways.

Intel® Personal Internet Client Architecture

The open architectural framework of the Intel® PCA allows separate development of applications and communication subsystems and speeds development and deployment of wireless Internet devices, applications, and services. It helps enable developers to innovate new wireless Internet devices, applications, and services faster than ever before.

Intel PCA decouples the applications subsystem from the communication subsystem through an open physical and logical bus interface, while providing a link to the memory subsystem. This empowers developers to drive application development to improve functionality and reduce time to market, independent of communication standards.

Intel PCA framework enables developers to design a single platform to support a broad range of products, from cell phones and smart phones to PDAs and automotive clients. Intel PCA supports application compatibility across multiple levels of hardware integration to protect their platform design and software investments. The benefit is that Intel PCA provides applications developers shorter development cycles and an open architecture that allows for rapid adaptation of applications across platforms and devices, resulting in faster time to market. Customers—whether consumer or corporate users—benefit from a greater availability of applications, broader deployment of services and networks, and more capable wireless platforms.

Intel® UPnP SDK

Intel has created an open source SDK that enables manufacturers of home-networked devices and applications to add UPnP functionality to their products. The Intel UPnP SDK is designed to help the software developer build the features described in this paper into his devices. The kit provides a comprehensive application programming interface (API), source code examples, and complete documentation for the implementation of UPnP-compliant control points and devices. The Intel UPnP SDK is available to Pocket PC developers as part of the Intel PCA Developer Network.

Now is the time for PCA and UPnP technology

Get connectivity for your products

Join the increasing number of software and mobile/wireless hardware developers who are adding UPnP technology to their products. Facilitated by the Intel UPnP SDK, Intel along with other companies such as Microsoft, Intel, D-Link, GlobespanVirata, Linksys, Axis and many others have launched or will soon launch products supporting UPnP technology. Intel makes it easy to do with its UPnP SDK. You can download the SDK by joining the Intel PCA Developer Network.

Get involved in creating the future

To get more involved in the development of the UPnP standard, join the UPnP Forum. There are currently over 450 members who support the UPnP format, including 3Com, Alcatel, Cisco, Dell, Ericsson, HP, Maytag, Nokia, and Xerox, among others. Learn more about the UPnP Forum at the organization's Web site. (www.upnp.org)

Join the Intel PCA developer network (PCADN) for technical data, marketing opportunities, and industry connections that accelerate the innovation and marketing of wireless Internet solutions. You can download the Intel PCA Development Kits for the Intel® PXA250 and PXA210 applications processors. (www.intel.com/pca)